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ABSTRACT

This paper discusses the results of a study comparing the psychometric qualities of two forms of a survey, one administered in paper-and-pencil format and the other administered in Web format. The survey addressed the topic of college course anxiety and was used to survey a sample of undergraduate students (n=36). The psychometric qualities investigated include the overall reliability (internal consistency) and item analyses of the 56 individual survey items for both the paper-and-pencil and Web surveys. With respect to reliability, results reveal a good deal of similarity between the two modes of survey delivery. Analysis of the paper-and-pencil survey data generated a Cronbach's alpha of 0.91; analysis of the Web survey data generated value of 0.88. Further internal comparisons of the item analyses revealed very similar patterns in the responses to individual items, indicating that the two modes of survey delivery were quite comparable. The Web version of the survey is attached. (Contains 1 table, 2 figures, and 17 references.) (Author/SLD)

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THE MOUSE OR THE PENCIL?

A PSYCHOMETRIC COMPARISON OF WEB-BASED AND TRADITIONAL SURVEY METHODOLOGIES

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Running head: A PSYCHOMETRIC COMPARISON OF SURVEY METHODOLOGIES...

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Abstract

This paper discusses the results of a study comparing the psychometric qualities of two forms of an identical survey: one administered in paper-and-pencil format and the other administered in Web format. The survey addressed the topic of college course anxiety and was used to survey a sample of undergraduate students ($N = 36$). The psychometric qualities investigated include the overall reliability (internal consistency), and item analyses of the 56 individual survey items for both the paper-and-pencil and Web surveys. With respect to reliability, results reveal a good deal of similarity between the two modes of survey delivery. Analysis of the paper-and-pencil survey data generated a Cronbach's α of .91; analysis of the Web survey data generated a value of .88. Further informal comparisons of the item analyses revealed very similar patterns in the responses to individual items, indicating that the two modes of survey delivery were quite comparable.

The Mouse or The Pencil?
A Psychometric Comparison of Web-Based and Traditional Survey Methodologies

Background

The Internet has had a substantial impact on the field of survey research (Shannon, Johnson, Searcy, & Lott, 2001). This is evidenced by the growing number of electronically administered surveys over the past several years. Web surveys—which Dillman (1998) has referred to as one type of "self-administered" survey—are an extremely promising method of data collection (Schillewaert, Langerak, & Duhamel, 1998). Young and Ross (2000) state that the use of the Internet to collect data may be one of the most profound developments in survey research. Witte, Amoroso, and Howard (2000) indicated that Internet research is "an area marked by great potential but also little experience" (p. 180). Specifically, the World Wide Web can be used as a resource for obtaining and efficiently processing large amounts of data, often the type collected as a result of administering a survey (Carbonaro & Bainbridge, 2000). Unlike more traditional survey delivery methods (e.g., mail and telephone), it is not clear what principles should guide the construction and implementation of electronic surveys (Shannon et al., 2001).

Advantages of Web surveys include a high rate of response, short time frame for the collection of responses, and time and cost savings. The Web certainly addresses the need for a less expensive and more expedient method of data collection (Heflich & Rice, 1999; Schillewaert et al., 1998). Furthermore, several additional benefits of using the Web for

data collection have been identified (Carbonaro & Bainbridge, 2000; Mertler, 2001, 2002a, 2002b; Schillewaert et al., 1998; Shannon et al., 2001). These benefits include a faster response, protection against the loss of data, easy transfer of data into a database for analysis, cost savings, convenience for the respondent, the possibility of wider geographic coverage, and a potentially better response rate – although this "advantage" is not uniformly agreed upon by the community of survey researchers (Matz, 1999).

However, it is important to note, as with any method of data collection, there also exist disadvantages. These include the potentially nonrandom nature of the sample, unavailability of population lists, computer access to the survey, and various technology-related issues. Additional limitations include the inability to clearly define the population, lack of technological familiarity on the part of respondents or their willingness to use a computer to complete the survey, the potential for being able to identify respondents, and browser incompatibility problems (Carbonaro & Bainbridge, 2000; Schillewaert et al., 1998; Shannon et al., 2001).

One of the most substantial concerns about Web surveys is the potential nonrandom nature of the respondent group (Mertler, 2001, 2002a, 2002b; Witte et al., 2000). However, the issue of nonrandomness is not unique to Web-based survey research and can be addressed through the maintenance of an accurate list of population members, when feasible. Survey research professionals have suggested that Web surveys be used primarily with specifically identifiable samples such as "in-house" employee groups (Shannon et al., 2001). Alternatively, Taylor (2000) has suggested that we remember that online data collection is not based on probability sampling, but rather on "volunteer" or "convenience" sampling.

Beyond the strengths and weaknesses of this methodology, Carbonaro and Bainbridge (2000) have outlined several other issues with which researchers should be concerned. First, access to the survey must be as simple as possible for all respondents. The more complex the process of completing the survey, the lower the resultant response rate will undoubtedly be. Second, the process must be designed such that respondents of the Web survey are able to complete it with the same relative ease as if they had received a traditional paper version. Third, some sort of security system is required, in order to maintain the integrity of the data, but also to put at ease the mind of the respondent. Finally, completion of the survey must require only minimal computer skills—including the ability to use an Internet browser, enter a specific URL, use a mouse, and type on a word processor. Matz (1999) and Shannon et al. (2001) also point out that a Web survey must somehow be publicized. Some mechanism must be used to direct potential respondents to the actual URL containing the survey, either by providing a link to the URL in an email message or by providing the URL in a cover letter.

There exists somewhat of a void in the research literature on the topic of electronic surveys, in particular, comparing their effectiveness to that of mail surveys (Underwood, Kim, & Matier, 2000). Often, the results of Web-based surveys differ when compared to written questionnaires and telephone surveys (Taylor, 2000), although Saphore (1999) found that there were no differences in the pattern of responses between a Web survey and an identical pencil-paper form of the same survey. Furthermore, he concluded that there were no differences in the psychometric qualities of the two forms of the survey.

In another comparison-type study, Matz (1999) compared the responses received from a Web survey with those received from a traditional paper-and-pencil survey. She found no significant differences between the demographic characteristics – such as age and gender – of the respondents completing the Web survey and those completing a mailed, written survey. Additionally, she found no significant differences between the content or pattern of responses for either group. The only significant finding – albeit, a substantial one – was that the overall response rate for the paper survey (43%) was significantly higher than that for the Web survey group (33%). A final result discussed by the researcher was that the paper instrument seemed to provide more flexibility to the respondents. They could freely make comments about items they did not understand or felt were ambiguous. In spite of these last two findings, she concluded that Web surveys seemed to be a reasonable alternative – or, at least, equally suspect – to mail surveys.

Underwood et al. (2000) also conducted an empirical study comparing the characteristics of Web and mail surveys. When the data from the administration of the same survey via two different media were compared, the researchers concluded that women responded at greater rates than men, regardless of survey method, and that underrepresented minority students generally responded at lower rates than Caucasians, Asian Americans, and International students, also regardless of survey method employed. This led them to further conclude that the characteristics of respondents, rather than specific survey method used, are more closely related to response rates.

Because of the technological skills required to develop and implement Web-based surveys, the driving force behind their use has been technology specialists (or at least

someone with a background in technology) and *not* survey professionals (Dillman & Bowker, 2001; Shannon et al., 2001). In order to harness the potential for using the Internet for the collection of valid and reliable data, those most knowledgeable about survey research methodology – specifically with respect to causes and consequences of survey error (Dillman & Bowker, 2001) – must take an active role in its development as a viable methodology for data collection. Specifically, research is needed in order to compare responses from Web surveys and those conducted in more traditional manners (Dillman & Bowker, 2001).

Purpose of the Study

The primary purpose of this study was to add to the knowledge base regarding the use of Web-based surveys as a viable means of collecting data for educational research. Specifically, the researchers investigated and compared the relative effectiveness, psychometric qualities, and response patterns of two versions of the same survey: one delivered as a Web-based survey and the other as a paper survey. A secondary purpose was to assess the specific methods used in this study for data collection in order to refine the procedures for future extensions of this line of inquiry.

Methods

In the Spring 2002 term, we contacted the directors of an introductory English course (writing composition) and an introductory Math course (statistics) to obtain permission to deliver surveys to randomly selected sections. We gained access to 15 writing sections and 18 statistics sections. From each course, we randomly selected 6 sections from which we recruited students. The reason for the selection of students in two courses was to

investigate (in a separate study) the existence of differential course anxiety. For purposes of this paper, only survey data resulting from the English class participants were used.

Course instructors in the 12 selected sections delivered the surveys during class in one of two formats: either paper-and-pencil or via the Web. We provided instructors with a script from which to read after handing out letters to their students introducing the survey. Six of the twelve sections (three writing, three statistics) received the paper-based survey and the other six received instructions for accessing and completing the Web-based survey. Students were asked to complete the surveys within two weeks.

Items from two instruments measuring student attitudes toward statistics, both called the STATS (Sutarso, 1992; Rogness, 1993) were collapsed into one instrument which we called the Course Attitude Scale (see Figure 1). Duplicate items or items with wording similar to others were removed, for a total of 56 unique items in the final scale. All items on the new scale were re-worded to be generic to any course, not just statistics. So, an item such as "If I were not required to take a statistics course for my major, I wouldn't take one" was changed to read "If I were not required to take THIS COURSE for my major, I wouldn't take it." The purpose of the study reported here was to pilot test not only this new instrument, but also the dual modes of delivery.

Insert Figure 1 about here

For the two modes of survey delivery, analyses included the computation of internal consistency reliability (alpha) coefficients and individual item analyses. All analyses were conducted using SPSS (v. 10).

Results

Although the data resulting from the administration of the two surveys were analyzed for the entire group, the analyses were primarily based on formal techniques followed by informal comparisons of the results by the two subgroups – namely, the data resulting from the traditional paper-and-pencil method of delivery (n = 21) and those resulting from the Web form of the survey (n = 15). The return rate for the total survey was equal to 28%; the return rate for the paper-and-pencil administration was equal to 34%, while that for the Web administration was equal to 22%. It should be noted that the researchers recognize the fact that these are low return rates. This was likely due to the timing and procedures used for data collection.

Analysis of the overall scale comprised of 56 items for the entire group (N = 36) revealed an internal consistency measure (i.e., Cronbach's index of internal consistency; also known as the alpha coefficient, or α) equal to .90, indicating a high degree of reliability. The internal consistency measure for the "paper" sample (α = .91) was quite similar to that for the "Web" sample (α = .88).

The resulting data were also analyzed at the level of the individual items. Specifically, the internal consistency of the overall scale with each individual item removed was determined. This is typically done in order to assess the contributions of individual items to the total scale. The resulting analysis reports an alpha (α) coefficient for the total scale *minus* the particular item. A "new" α coefficient (i.e., for the 55-item scale) that is *lower* than that for the 56-item scale indicates that the particular item did in fact contribute to the total scale; in other words, when the item was removed, the overall reliability decreased. In contrast, a "new" α coefficient that is *higher* than that for the

original scale indicates that the particular item did not contribute to the overall scale; in other words, when the item was removed, the overall reliability improved.

Of the 56 items appearing on the survey administered in a traditional manner (i.e., paper-and-pencil), analyses of 13 items revealed improved internal consistency values when they were individually removed from the scale. The results of the individual item analyses for the survey administered via the Web were similar. Of the 56 items, 19 showed improved internal consistencies when removed from the scale. A summary of analyses of these individual items and the amounts of improvement in overall scale reliabilities are presented in Table 1 and Table 2, respectively. Furthermore, it is important to note that, upon informal comparison of the list of 13 items identified from the paper-and-pencil method and the 19 items identified from the Web delivery method, 6 items were common to both lists.

Insert Table 1 about here

Insert Table 2 about here

Upon further informal comparison between the two sets of results, it is also interesting to note that two items – namely Items 53 and 55 – both demonstrated substantial amounts of change in the value for alpha (α) for their respective modes of survey delivery, providing further evidence of similar patterns of response. With respect to the paper-and-pencil data, these two items ranked second and first, respectively, in

terms of the greatest amounts of change in alpha; with respect to the Web data, they ranked first and third, respectively.

Discussion

Web-based surveys have begun to have a profound impact on survey research and are likely here to stay. Similar to previous studies—e.g., Underwood (2000), Matz (1999), and Saphore (1999)—this study has provided evidence of the similarities, at least with respect to psychometric qualities, between Web-based and paper-and-pencil survey methodologies. With respect to the primary purpose of this study, very similar values for internal consistency reliability were observed for the two versions of the survey. Although not identical, the patterns of responses—as identified by contributions to the overall scale—across the two modes of delivery were fairly comparable. With respect to the secondary purpose of this study, assessment of the procedures used for data collection revealed some problems.

Although the various instructors agreed to participate, we were never sure of how many students *actually* received the information and survey since we based our return rates on class enrollments (e.g., if students were absent and did not receive the information, they were included as nonrespondents in the return rates). The students may not have been properly motivated to respond to their respective surveys. This could have been a substantial cause of the poor return rates for the two forms of the survey, as well as a factor in our inability to accurately calculate the return rates. Additionally, although we provided the instructors with scripts to be read to students, we could never be sure exactly how that part of the data collection was handled. Unfortunately, this was necessitated by the lateness in the semester when permission

from departments was obtained to approach instructors about participating in the study, and when individual instructors agreed to participate.

Furthermore, it became apparent to us that soliciting participation for a Web-based survey should be done electronically, and not by providing the URL on a piece of paper. It is our belief that providing a URL on a piece of paper (e.g., in a cover letter) is *not* equivalent to handing participants an actual paper-and-pencil survey. The latter is a more "direct" form of survey delivery—it is easy for the participant to respond. When participants are directed to an electronic survey (e.g., on a Web page) in the manner we used here, it takes some initiative on their part to go to a computer, type in the correct URL, and then complete the survey—it creates somewhat of an "extra" step when compared to the more traditional mode of delivery. Requesting the participation of individuals via email (for example) would allow researchers to include in the "cover message" a link to the Web survey, thus making completion of the survey a much easier—and comparable—process.

Research is beginning to demonstrate that a Web-based approach is a viable means of gathering survey data. However, further research must be conducted on this mode of delivery in order to pass judgment on its relative merits. There are several advantages to electronic surveys, in general. These include such things as cost and time savings, as well as the ease of transfer of responses into a database. Are these advantages over paper-and-pencil surveys great enough to "counteract" the problems associated with nonrandom samples? Are potential respondents comfortable enough with technology to respond to surveys online? Or do they remain apprehensive about potentially realistic concerns such as anonymity, confidentiality, and security of their provided information? If the answer to the latter question is "yes," do we as researchers end up with a

"differential" type of random sample resulting from respondent self-selection? This, of course, is a concern for any type of survey research, but can we be sure that we are not ending up with a sample whose characteristics are different from those realized through paper-and-pencil forms of surveys? To address these and related issues, further research is most certainly called for.

Web-based surveys must adhere to the principles of sound survey design and implementation. In some instances, those principles may need to be adapted in order to "match" the methodology, but without jeopardizing the integrity of the data or risking the anonymity and confidentiality of the respondents. As this methodology is refined, it will undoubtedly be used more frequently to conduct scholarly research. Empirical studies, such as this one, are necessary in order to guide this process of methodological refinement.

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Figure 1

The Course Attitude Scale
(Web version)

Welcome...

and thank you for taking a few minutes to complete the...

Course Attitude Scale

DIRECTIONS:

For each statement, please respond by indicating the extent to which each statement is true of you. Indicate your responses by clicking on the appropriate button.
When you have finished, click on the **"SUBMIT"** button at the bottom of the page to send your responses.

	ENGLISH 112	MATH 115
In which class did you hear about or receive this survey?	1 O	2 O

Thinking only about the class you checked above,
please indicate the extent to which each of the following statements is true of you...

NUMBER	STATEMENT	NOT TRUE OF ME	.....	.....	.....	.....	VERY TRUE OF ME
1.	Learning in this course is easy for me.	1 O	2 O	3 O	4 O	5 O	6 O
2.	I understand this course better than the majority of people in my class.	1 O	2 O	3 O	4 O	5 O	6 O
3.	This course makes me anxious.	1 O	2 O	3 O	4 O	5 O	6 O
4.	I like working with numbers.	1 O	2 O	3 O	4 O	5 O	6 O
5.	I enjoy working with calculators.	1 O	2 O	3 O	4 O	5 O	6 O
6.	I enjoy working with computers.	1 O	2 O	3 O	4 O	5 O	6 O
7.	My mother likes/liked this subject, so I will.	1 O	2 O	3 O	4 O	5 O	6 O
8.	My father likes/liked this subject, so I will.	1 O	2 O	3 O	4 O	5 O	6 O
9.	I feel that this course is only for men.	1 O	2 O	3 O	4 O	5 O	6 O
10.	I feel that this course is only for women.	1 O	2 O	3 O	4 O	5 O	6 O
11.	This course is very useful for my major.	1 O	2 O	3 O	4 O	5 O	6 O
12.	This course will improve my research ability.	1 O	2 O	3 O	4 O	5 O	6 O
13.	This course will be important for my career.	1 O	2 O	3 O	4 O	5 O	6 O
14.	I will be more competent in my subject area when I master this course.	1 O	2 O	3 O	4 O	5 O	6 O
15.	I can master this course with a great deal of effort.	1 O	2 O	3 O	4 O	5 O	6 O
16.	I study for this course regularly even when there is no specific assignment.	1 O	2 O	3 O	4 O	5 O	6 O
17.	I see my instructor when I do not understand something in this course.	1 O	2 O	3 O	4 O	5 O	6 O
18.	I ask questions in this course when I do not understand.	1 O	2 O	3 O	4 O	5 O	6 O
19.	I believe this course is a very interesting subject.	1 O	2 O	3 O	4 O	5 O	6 O
20.	If this course were not required for my major, I would not take it.	1 O	2 O	3 O	4 O	5 O	6 O
21.	I do not like this course.	1 O	2 O	3 O	4 O	5 O	6 O
22.	I am able to understand this subject as well as any other subject.	1 O	2 O	3 O	4 O	5 O	6 O

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23.	I try to do as little work as I can in this course.	1 O	2 O	3 O	4 O	5 O	6 O
24.	I doubt that any teacher could make me more comfortable with this subject.	1 O	2 O	3 O	4 O	5 O	6 O
25.	The right instructor could probably make me enjoy this subject.	1 O	2 O	3 O	4 O	5 O	6 O
26.	I feel insecure while taking exams.	1 O	2 O	3 O	4 O	5 O	6 O
27.	I am confident that I could do work which required me to use computers.	1 O	2 O	3 O	4 O	5 O	6 O
28.	No matter how hard I study, I will not do well in this course.	1 O	2 O	3 O	4 O	5 O	6 O
29.	I think being enrolled in this course is undesirable.	1 O	2 O	3 O	4 O	5 O	6 O
30.	I would like to take more courses in this subject.	1 O	2 O	3 O	4 O	5 O	6 O
31.	No matter who teaches this course, I feel I would never be good at it.	1 O	2 O	3 O	4 O	5 O	6 O
32.	I think this course is worthwhile for most professionals in my field.	1 O	2 O	3 O	4 O	5 O	6 O
33.	I have trouble thinking mathematically.	1 O	2 O	3 O	4 O	5 O	6 O
34.	I have trouble thinking creatively.	1 O	2 O	3 O	4 O	5 O	6 O
35.	I forget information that I actually know during an exam due to anxiety.	1 O	2 O	3 O	4 O	5 O	6 O
36.	I have little self-confidence when it comes to using computers.	1 O	2 O	3 O	4 O	5 O	6 O
37.	I feel at ease doing the work for this course.	1 O	2 O	3 O	4 O	5 O	6 O
38.	Given a choice, I would prefer not to have to work with this material.	1 O	2 O	3 O	4 O	5 O	6 O
39.	I think that I am good at this material.	1 O	2 O	3 O	4 O	5 O	6 O
40.	I like working with words.	1 O	2 O	3 O	4 O	5 O	6 O
41.	I become very nervous prior to taking an exam.	1 O	2 O	3 O	4 O	5 O	6 O
42.	I try to avoid circumstances where I have to use this material.	1 O	2 O	3 O	4 O	5 O	6 O
43.	I would like to take another class in this subject even if I wasn't required to do so.	1 O	2 O	3 O	4 O	5 O	6 O
44.	While taking a test, I feel calm.	1 O	2 O	3 O	4 O	5 O	6 O
45.	No matter who teaches this course, I would never like it.	1 O	2 O	3 O	4 O	5 O	6 O
46.	I think this course is an important part of my career education.	1 O	2 O	3 O	4 O	5 O	6 O
47.	The thought of working with a computer makes me nervous.	1 O	2 O	3 O	4 O	5 O	6 O
48.	I find it difficult to stop worrying about how I did on an exam when it is over.	1 O	2 O	3 O	4 O	5 O	6 O
49.	I think that using a computer is often more trouble than it's worth.	1 O	2 O	3 O	4 O	5 O	6 O
50.	I wish that I didn't have to take any course in this subject.	1 O	2 O	3 O	4 O	5 O	6 O
51.	I like the thought of using computers.	1 O	2 O	3 O	4 O	5 O	6 O
52.	I think studying this material is a beneficial experience.	1 O	2 O	3 O	4 O	5 O	6 O
53.	The right instructor could probably make this course easy for me.	1 O	2 O	3 O	4 O	5 O	6 O
54.	One of the parts of this course which I dread is having to use computers.	1 O	2 O	3 O	4 O	5 O	6 O
55.	I get anxiety if I even think about working on this course material.	1 O	2 O	3 O	4 O	5 O	6 O
56.	I would never consider taking this course as an elective.	1 O	2 O	3 O	4 O	5 O	6 O

Submit Survey

Thank you for participating in this research study.

If you have questions or comments about this survey, please feel free to contact us...

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Table 1

Identified Items and Recalculated Reliabilities for Item Analysis of Data Resulting from Paper-and-pencil Survey

Survey Item Number	Alpha Coefficient (If Item Deleted) [a]	Amount of Change In Reliability
Item 3 [b]	.9053	+.0001
Item 4 [b]	.9059	+.0007
Item 8	.9063	+.0011
Item 16 [b]	.9054	+.0002
Item 18	.9056	+.0004
Item 23	.9082	+.0030
Item 24	.9114	+.0062
Item 27	.9089	+.0037
Item 34	.9057	+.0005
Item 47	.9061	+.0009
Item 53 [b]	.9122	+.0070
Item 54 [b]	.9062	+.0010
Item 55 [b]	.9139	+.0087

[a] Alpha coefficient of the total scale was equal to .9052 (rounded to .91).

[b] These items were also identified following the item analysis of data resulting from the Web administered survey.

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Table 2

Identified Items and Recalculated Reliabilities for Item Analysis of Data Resulting from Web Survey

Survey Item Number	Alpha Coefficient (If Item Deleted) [a]	Amount of Change In Reliability
Item 3 [b]	.8813	+.0002
Item 4 [b]	.8850	+.0039
Item 5	.8858	+.0047
Item 6	.8823	+.0012
Item 9	.8814	+.0003
Item 10	.8814	+.0003
Item 15	.8842	+.0031
Item 16 [b]	.8819	+.0008
Item 17	.8847	+.0036
Item 22	.8828	+.0017
Item 26	.8879	+.0068
Item 31	.8816	+.0005
Item 33	.8902	+.0091
Item 35	.8820	+.0009
Item 36	.8845	+.0034
Item 48	.8876	+.0065
Item 53 [b]	.8927	+.0116
Item 54 [b]	.8822	+.0011
Item 55 [b]	.8901	+.0090

[a] Alpha coefficient of the total scale was equal to .8811 (rounded to .88).

[b] These items were also identified following the item analysis of data resulting from the paper-and-pencil administered survey.

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